Improving Access To and Use of Ocean Observations from Animal Borne Sensors

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LONG-TERM GOALS

The U.S. IOOS Program (IOOS) of the National Oceanic and Atmospheric Administration and the U.S. Navy's Office of Naval Research (ONR) Marine Mammals and Biological Oceanography Program propose to collaborate with the Tagging of Pelagic Predators (TOPP) program – a project of the Census of Marine Life – to facilitate improved access and use of associated ocean observing data, particularly physical oceanographic data, by ocean modelers and other scientists. Technical staff at IOOS and ONR will work with scientists and computer programmers at TOPP to implement web-based data services and other community-based software tools and technologies that can enable broader exposure of TOPP animal tagging data sets based on customer requirements for data representation, metadata, QA/QC, format and delivery. The project will be conducted over a 6-8 month period.

The goal is to demonstrate the application of IOOS-based data interoperability tools and technologies for achieving broader exposure and use of ocean observations data collected from animal borne sensors. It is anticipated that this will help improve:

- forecasting of ocean conditions, particularly in sparsely sampled regions;
- prediction of animal distributions based on bio-physical coupling.

OBJECTIVES

1. Document customer-based requirements for improved access to TOPP data, particularly physical oceanographic data collected from elephant seals and sharks for use by an ocean modeling customer.

2. Evaluate means to meet customer requirements using existing community tools and technologies for data access, representation, and distribution.

3. Implement at TOPP a new data service and protocol that meets the ocean modeling customer requirements.

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4. Complete a plan describing additional future opportunities to expand the initial TOPP-IOOS-ONR partnership to additional customers/applications.

APPROACH

U.S. IOOS is a coordinated network of people and technology that work together to generate and disseminate continuous observing data, information, models, products and services for U.S. coastal waters, ecosystems, Greats Lakes and oceans. Most of the ocean observations data collected and distributed by IOOS are physical measurements of ocean features and characteristics (water temperature, wave height/direction, circulation, salinity, etc.). Two recently emerging areas of focus for IOOS are improved access to ocean measurements by modelers using a suite of community-based tools and protocols and enabling broader access to and use of biological observations using a very similar suite of enabling tools. The purpose of this project is to engage in a small scale collaboration with an important emerging data provider of both physical and biological observations – the Tagging of Ocean Pelagic Predators or TOPP program that is jointly managed by Stanford University's Hopkins Marine Lab in Monterey, CA, the University of California, Santa Cruz's Long Marine Laboratory, and NOAA's Fisheries Environmental Research Division in Pacific Grove, CA.

TOPP began in 2000 as one of 17 projects of the Census of Marine Life, an ambitious 10-year, 80-nation endeavor to assess and explain the diversity and abundance of life in the oceans, and where that life has lived, is living, and will live. Several dozen TOPP researchers from eight countries began venturing into offshore waters, remote islands, and along rugged coastlines to attach satellite tags to 22 different species of top predators that roam the Pacific Ocean. As of 2011, they have tagged more than 4,500 animals, including elephant seals, bluefin tunas, yellowfin tunas, white sharks, whales, leatherback turtles, squid, albatross and sooty shearwaters (Block et. al., 2011).

Technical staff from US IOOS and MMB will work closely with scientists and computer programmers at TOPP in documenting an initial set of modest customer "requirements" for exposing physical oceanographic measurements from elephant seal and shark tags to ocean modelers who will use these data to improve their capacity to forecast ocean conditions in the Western Pacific Ocean. The initial customer will be an ocean modeler at Naval Oceanographic. The project team will work to match existing data access/distribution tools and technologies to customer requirements and implement and test an initial data service to meet the customer needs. Following this initial phase of the project, the work may be expanded – assuming resources will allow – to one or more additional "customers" and associated requirements via a series of additional implementations also aimed at the overall goal of broader and easier access to TOPP ocean observations. The project team will complete a project summary report documenting the work accomplished and describing recommended priority applications for additional collaboration.

WORK COMPLETED

As we have not yet received the funding for this project, the work completed to date is all preparatory. As part of the ongoing Global Tagging of Pelagic Predators (GTOPP) and GulfTOPP projects, we have created a data management system consisting of hardware and software specifically developed to deal with proprietary and platform-specific (i.e., tag-specific) software, data accumulation, quality verification, decoding operations and generation of derived data products, while incorporating multi-level security, timely data flow and consistency across multiple platforms. To support sustainable data

delivery, the system combines two decentralized, autonomous relational database management systems (RDBMS) into a single federated database system via network connections and shared protocols. Although both constituent databases utilize the same open-source RDBMS, PostgreSQL, each system has its own distinct table schema specifically designed to manage conspecific data, partially distinct data dictionary components, and client interfaces. While network access reliably delivers relational database table information, distribution of the large time-series data files is accomplished using native Apache web server functionality and OPeNDAP's client-server architecture and network protocol.

Within this infrastructure we have created a virtual machine which will house the database and access tools specifically for this project. A conference call is planned for this Friday, November 4, to begin to identify the client requirements for data delivery from this system.

RESULTS

None to date.

IMPACT/APPLICATIONS

The ability to use animal-borne sensors to acquire unique oceanographic datasets, at times and in places where other approaches would be prohibitively dangerous or expensive, has been integral to the vision of the TOPP program since its inception in 1999 (Boehlert et. al., 2001). Over the past decade the TOPP research team has engaged multiple collaborators from the oceanographic research community to help us refine our approach to utilizing "animal oceanographers," and has led to a number of key enabling protocols to assess the accuracy and precision of measurements made through animal-borne sensors – such that these datasets can be integrated into ocean observing systems. Furthermore, we have developed a statistically-robust state-space model which allows us, for the first time, to create model animal tracks with known errors around each location (Jonsen et. al., *In press)*. Thus, we can now provide highly detailed datasets from animal-borne sensors with comparable parameters to other autonomous oceanographic sampling devices including ARGO floats, gliders, buoys, etc. And we can do so with higher sampling rates, across broader geographic and bathymetric range, and at lower costs than many of these alternatives – potentially enhancing our ability to understand, model and predict ocean conditions.

RELATED PROJECTS

None

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PUBLICATIONS

None to date.